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LEARNING, COOPERATION AND INNOVATION WITHIN LOCAL INNOVATION AND PRODUCTION SYSTEMS: EVIDENCES FOR THE ECONOMY OF SANTA CATARINA STATE OF BRAZIL

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Abstract: The analysis developed aims at identifying patterns regarding the innovative dynamics of enterprises which comprise Local Innovation and Production Systems (LIPS) in the State of Santa Catarina (South of Brazil), with basis on a set of 298 interviews made with enterprises from five LIPS involving the following activities: electrical and metal-mechanical industry, in the region of Joinville; furniture and wood, in the regions West and Itaguaçu Valley; plastics industry in the southern region of the state (around Criciuma City); fishing in the estuary of Itajai River. From an evolutionary theoretical perspective, methodological procedures were adopted for building indicators that allow for identifying clusters of enterprises that share common patterns of learning, cooperation and innovation in the scope of the LIPS surveyed. The patterns of innovative effort, external learning-cooperation and innovative performance are discussed with basis on the results of cluster analysis techniques applied to groups of enterprises in the sample, which share similar characteristics regarding chosen factors. Subsequently, a model for categorizing new enterprises according to identified patterns is suggested. The analysis enabled us to identify three clusters with similar patterns regarding the characteristics of innovative performance, innovative efforts and external learning based on cooperative actions. The suggested model for classification obtained a percentage of accuracy of 96.31%. It is suggested that the innovative dynamics of each LIPS would be strongly influenced by the relative participation of the enterprises in each of these clusters.

Key Words: Learning processes, cooperation and innovation; local productive arrangements; Santa Catarina.

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Introduction:

There is a growing body of literature supporting that innovation by firms is enhanced, and depends upon learning mechanisms and cooperative practices. However, despite the consensus regarding the notion that cooperation has important implications for the innovative performance of firms, it is also undeniable that there is a huge diversity in the patterns of cooperative practices among firms, even in the same sector, across countries and regions. In order to cope with the localized character of the process of learning and innovation, as well as with the construction of cooperative practices in the context of a "new learning economy" (Lundvall and Johnson, 1992), RedeSist[1], the Brazilian Research Network on Local Productive and Innovative Systems developed the concept of local innovation and production systems (LIPS). This concept is associated with groups of economic, political and social agents localized in the same area, performing related economic activities and presenting formal and informal articulation, interaction, co-operation and learning processes (Cassiolato, Lastres and Maciel 2003).

This paper develops an analysis based on a set of indicators for measuring forms of interaction and learning in LIPS. In order to capture the diversity of learning processes and innovative activities in those systems, the paper introduces a set of indicators that express the intensity and type of information flows between agents, the dynamics of learning processes, the intensity of cooperative practices and the characteristics of innovations generated by firms inserted in LIPS. The data used in the analysis were collected through interviews applied to 298 firms inserted in five LIPS located in Santa Catarina, a federative state situated in the South region of the Brazilian territory. The paper develops an exploratory analysis about the main determinants of the patterns of learning, cooperation and innovative performance of the firms inserted in those LIPS. The indicators identified are manipulated through the use of multivariate techniques, in order to identify groups of firms with similar characteristics. The multivariate analysis applied to the sample permits the identification of general patterns concerning the process of learning, cooperation and innovative performance. The analysis also tries to identify statistical functions in order to classify other firms according to the patterns identified from the sample.

The paper is organized in six sections. Section 2 describes the main elements of the analytical framework of the analysis. Section 3 presents the methodological procedure used to calculate the indicators applied in the analysis. Section 4 presents some structural characteristics of the LIPS investigated in the analysis, based on the indicators previously identified. In section 5, the paper presents the results of the multivariate analysis applied to the sample. Section 6 identifies statistical functions in order to classify other firms according to the patterns identified from the sample. The last section presents the main conclusions of the analysis.

2. Analytical Reference:

The objective of this paper is to identify how interactive processes influence the innovative performance of firms inserted in local innovation and production systems (LIPS). RedeSist defines LIPS as groups of economic, political and social agents localized in the same area, performing related economic activities and presenting formal and informal articulation, interaction, co-operation and learning processes (Cassiolato, Lastres and Maciel 2003). Generally they comprise (a) firms: designing, producing and commercializing final goods and services, suppliers of inputs (raw materials, equipment, etc.) and service providers; (b) other public and private organizations in charge of education and training, R&D, engineering, financing, social and economic development, co-operatives, economic, social and political associations and representations, etc. This concept stress the importance of the local generation of innovation, through the exchange of tacit forms ok knowledge and through the use of newly codified knowledge and information (Malkell and Malmberg, 1999; Asheim and Isaken, 1996).

[1] RedeSist is the Brazilian Resarch Netwok on Local Productive and Innovative Systems based at the Economic Institute, Federal University of Rio de Janeiro, Brazil. (www.sinal.redesist.ie.ufrj.br)

According to the methodological framework that sustains the analysis of LIPS, it is recognized that geographical proximity is not enough for the achievement of collective learning processes and innovative dynamism. In fact, this proximity might be articulated with other elements, such as the institutional, cultural and technological context, in order to foster the existence of a innovative system. According to this perspective, the presence of multiple ties among local actors performs a critical role to strengthen competence building processes in these systems. On the one side, the establishment of those ties actors may provide the necessary conditions to promote localized learning processes and stable innovative paths based in incremental innovations. On the other side, in order to avoid the danger of geographical 'lock-in' related to the localized learning processes, the agglomerations must also show capabilities to break path dependency and change technological (Cooke and Morgan, 1998).

The concept of LIPS tries to articulate the static competitive advantages generated by the spatial agglomeration with dynamic competitive advantages obtained through the strengthening of learning practices and multiple forms of cooperation. In this perspective, positive externalities generated by the process of spatial agglomeration – such as mentioned in the original analysis of Marshall (1986) – are associated with structural and institutional factors that stimulate collective actions oriented to improvement of local competences and to the strengthening of the competitiveness of local agents. At the level of LIPS, it is supposed that the systematic interchange of information and knowledge generates a process of collective learning, which accelerates the diffusion of technological and organizational innovations. These flows involve intangible assets and the circulation of tacit knowledge. Although the generation of innovations intentionally developed in co-operation tends also to occur only in more structured systems, there are a lot of possibilities to improve the competitiveness of local productive systems due to informal mechanisms of learning. The evidence also shows that the competencies of firms inserted in those systems might be upgraded based on the capabilities and skills improved by the circulation of information. Moreover, the more tacit is the knowledge required to generate technological innovations, the more important will be the construction of the proper channels of contact and communication, in order to allow a systematic interchange of information between the agents integrated in those systems. Another aspect that must be stressed refers to the impacts of the interchange of information to the definition of industrial standards, normalization procedures and quality control techniques.

The concept of LIPS can also be articulated to a macro-institutional context in which productive systems are inserted. This context tends to be continuously reconfigured due to the diffusion an integration of multiple fonts of knowledge. In the context of a "knowledge economy" (Lastres e Cassiolato, 2005), the set of information and knowledge that might be integrated at the orbits of production, distribution and marketing becomes strongly important to value aggregation, generating new requirements to the development of resources and competences at the local level. In order to allow the integration of complex knowledge, particular importance might be attributed to interactive learning mechanisms structured at the local level. This process tends to transcend the sphere of the individual firm, involving the continuous interaction between those firms and other institutions inserted in local innovative systems. In this sense, learning-by-interaction becomes a critical aspect of LIPS. Given the tacit character of knowledge, innovation, production and value generation activities require several forms of interaction among economic agents, who in turn interact with institutions. In most cases the technological development of a firm depends on the capabilities of other firms through the production chain, competitors, clients and other agents and organizations. As an outcome, the greater the complexity of a learning process, the larger the frequency required for interactions.

Typically, interactions develop in the form of cooperative efforts, formal or informal. Then, cooperation can be seen as a particular case of learning-by-interacting. There is a growing body of literature supporting that innovation by firms is enhanced, and depends upon learning mechanisms and cooperative practices. In this sense, it is possible to differentiate horizontal cooperative links among firms inserted in similar stages of the value chain and vertical cooperative links involving firms, suppliers, customers and other agents and organizations. Among those organizations, it can

be mentioned research centers, technical schools, public institutions and private representative associations. All these agents represent the complex institutional context in which cooperative links are built. However, despite the consensus regarding the notion that cooperation has important implications for the innovative performance of firms, it is also undeniable that there is a huge diversity in the patterns of cooperative practices among firms, even in the same sector, across different LIPS. In other words, the complexity of knowledge flows, the multiplicity of the relations, the intensity of interactive learning mechanisms and the degree of cooperation among agents, for example, are factors which interfere in the decisive manner in which the learning processes take place, and therefore, in the generation, use and diffusion of knowledge. Hence, the relevance of understanding local characteristics for a more precise analyzes of (local) innovation systems.

The analysis carried on throughout the paper makes an attempt to fill up the gap from the lack of systematized information about the structure, the internal processes and the innovative performance of LIPS in Brazilian economy. In order to fill up this gap, RedeSist developed a methodology based on empirical surveys. It comprises a characterization of the LIPS: actors, linkages and flows (knowledge; goods and services), cooperation, hierarchy and coordination, embeddedness; etc. An important part of RedeSist's methodology contains the collection of data through interviews in firms and organizations. It includes plans for interviews, questionnaires (for different types of actors) sample and tabular plans. The questionnaire was designed with the aim of understanding learning and interaction processes by firms, evaluating externalities of the local environment and assessing different aspects affecting their performance.

Up to 2006 the data bank of RedeSist comprises data of more than 2000 firms in more than 50 LIPSs. Data used to provide indicators for this paper were collected from these questionnaires. The questionnaire was designed in such a way to make it compatible with Brazilian industrial and innovation surveys and is structured in five blocks. The first block intends to describe some basic characteristics of the firm, such as the size and number of employees. The second block gets information about the production process and qualification of the labor force. The third intends to capture the main characteristics of the innovation process, cooperation and learning among firms embedded in a local productive arrangement. The forth block concentrates on local externalities. Finally, the fifth block provides information regarding the impact of public policies to the performance of the firm in the local productive arrangements.

The third block of the questionnaire is the base to the proposal of indicators of learning and cooperation in local productive arrangements. In this block there are questions aiming at evaluating the origin of the information used for learning, internal or external to the firm. Other questions verify the intensity of interactions and the strength of the relationships with other agents in the local productive arrangement. The proposal of indicators detailed below are an attempt to go beyond the conventional input indicators (R&D expenditures, financial resources and workforce engaged in S&T activity) and output indicators (bibliometric indicators and patents) normally used as proxies for innovation. Through these indicators, a quantitative interpretation of the information collected from questionnaires used by RedeSist is developed, regarding to learning and cooperation processes in LIPS.

In order to guarantee some homogeneity of the institutional context in which the LIPS are inserted, the analysis was oriented to five LIPS located in Santa Catarina, a federative state situated in the South region of the Brazilian territory. The survey was based on interviews applied to 298 firms inserted in five LIPS: one specialized in the electro-metal-mechanical sector located in the region around the city of Joinville; two LIPS specialized in the wood and furniture sector located in the West region of Santa Catarina and in the Itaguaçu Valley; one specialized in the manufacture of plastics in the South region of Santa Catarina (around the city of Criciúma); one specialized in fishing located in the estuary of Itajaí River.

3. Methodology:

The analysis proceeded in the present study made use of information gathered through five study cases on LIPSs[2] located in the State of Santa Catarina[3], where 298 enterprises were surveyed. This information was extracted from the questionnaire[4] used in the ambit of the "Research Program on Micro and Small Enterprises within Local Productive Arrangements in Brazil", which provided a particular set of indicators that received statistical treatment suitable to the proposed objectives.

This work is based on the selection of a set of indicators that are used for catching important elements of the "dynamics" of the processes of cooperation, learning and innovation observed in the LIPS surveyed. A selected set of questions[5] extracted from the applied questionnaire was used, seeking to change qualitative attributes, such as the relevance ascribed by the firm to some particular event, into quantitative ones; that is, finding a value between 0 and 1 which expressed the firm's opinion about each event[6]. It is worth noting that such indicators were, at a first moment, individually calculated for each firm in the sample. By means of these indicators, it was sought to cover three main aspects related to the creation of local capabilities, namely: i) innovative effort; ii) external learning and cooperative actions; and iii) innovative performance. A set of 23 indicators, as indicated in Table 1, was selected so that to cover these mentioned dimensions in the analysis.

The first set of indicators regards to the innovative effort and suggests eight indicators. A first one assesses how frequently the enterprises carry out Research and Development (R&D) activities or accomplish external acquisition of these activities (CONSP&D). Complementarily, other three indicators evaluate the frequency in accomplishing innovative activities: regularity of acquisition of new technologies (CONSNOVTEC), regularity of pre-innovative effort (CONSESFPREINOV) and regularity of organizational updating (CONSATORG). Two indicators are used for capturing the strategies regarding the development of Human Resources. The first one refers to the importance put on activities for staff's training and capabilities building (ESFTRERH). The second indicator catches the relevance perceived by firms regarding the absorption of qualified human resources (ESFABSRH). The internal learning, for requiring actions related to systematization and subsequent dissemination of information drawn from several departments of the firm, is treated in this work as a form of innovative effort[7]. Two indicators are suggested for capturing these dimensions: internal learning related to the R&D department (APRINTP&D) and internal learning derived from other departments within the firms (APRINTDEMFONT).

A second set, which comprises ten suggested indicators, refers to external learning and cooperative actions, serving as a proxy for what the evolutionary literature defines as *learning-by interacting*. The indicators related to the importance of external sources of information for learning aim at gathering the agents based on the similarity of information obtained and used, as follows: learning through suppliers and customers (APREXVER), learning through competitors and other firms in the sector (APREXHOR), learning through institutions of science and technology (APREXC&T), learning through technical services (APREXSERESP), and learning through other agents (APREXDEMAG). The cooperative interactions can be classified as a specific form of learning, based on the use of external information sources (*learning-by-cooperating*). In this sense, the indicators capture the perception of firms regarding the importance of cooperative relationships developed with several agents. The indicator of "vertical cooperation" (COOPVER) deals with cooperative activities that are established with suppliers and customers. The indicator of "horizontal cooperation" (COOPHOR) tries to capture the relevance of cooperative relationships established with competitors and other firms in the sector. Three further indicators are suggested, regarding

[2] The criterion used for the selection of those LIPS is related to the demands of the project's funder, SEBRAE Nacional.
[3] The next section of this work presents some structural characteristics of the surveyed LIPSs.
[4] A complete version of the questionnaire is available at: www.neitec.ufsc.br.
[5] Presented in the Methodological Annex I.
[6] The mathematical formalization of the indicators is presented in the Methodological Annex II.
[7] Malerba (1992), in his seminal work on learning forms, emphasizes that learning derived from internal information sources can be treated as a kind of innovative effort, once it requires from the agents efforts towards catching, systematizing and disseminating such information, by means of the implementation of specific strategies.

"cooperation with S&T institutions (COOPINSTC&T), "cooperation with technical sectors" (COOPSERESP) and "cooperation with other agents" (COOPDEMAG).

In order to capture the level of innovative performance of agents, five indicators are suggested. The first two catch the most "radical"[8] innovations, respectively in products and processes, involving more exigent markets (new products for the national and international markets – INRDPRD), or those that more intensively influence the firm's operation sector (new processes for the sector of operation – INRDPRC). Innovations with an incremental or imitative character are grouped into two indicators referring to products (incremental innovation in products – INICPRD) and processes (incremental innovation in processes – INICPRC) and referring to the introduction of products and processes that are new to the firm, but that already exist in the market. Finally, a last indicator is related to the implementation of organizational innovations (INORG).

[8] The use of the term "radical" in the nomenclature of theses indicators is not referred to what Schumpeter (1942) calls "radical innovation". For this author, *radical innovation* refers to innovations which have as an outcome the break of a technological paradigm, thus fundamentally affecting the characteristics of an industry or even of the whole economy. The sense of the term radical, as noted in the present work, refers solely to innovations with a greater emphasis in technology, it is about new products aimed at more exigent markets and new processes for the sector of operation.

Table 1 – Indicators used:

Indicators	Captured Events
1) Indicators of innovative effort	
Regularity in performing R&D (CONSP&D)	Performing R&D performing within the firm; external acquisition of R&D.
Regularity in acquisition of new technologies (CONSNOVTEC)	Acquisition of machinery and equipment which implied significant technological improvement; and acquisition of other Technologies (software, licenses, patents, trade marks and trade secrets).
Regularity in pre-innovative effort (CONSESFPREINOV)	Industrial project related to products / processes either technologically new or significantly improved; and training program associated to the introduction of products / processes either technologically new or significantly improved.
Regularity in organizational updating (CONSATORG)	Implementation of programs of quality management or organizational modernization; and new forms of commercialization or distribution of products either new or significantly improved.
Training effort (ESFTRERH)	Training within the firm; training in technical courses within the cluster; training in technical courses outside the cluster; internships at either supplier or customer firms; and internships at firms of the group.
HR Resources absorption effort (ESFABSRH)	Hiring of technicians / engineers from other firms in the cluster; hiring of technicians / engineers from firms outside the cluster; absorption of graduates from universities located inside the arrangement ou near to it; and absorption of technical courses located inside the arrangement or near to it.
Internal learning R&D department (APRINTP&D)	Department of R&D as a relevant source of information for innovation.
Internal Learning other sources (APRINTDEMFONT)	Production area; Sales and marketing area; and customer service.
2) Indicators of external learning and cooperative actions	
Vertical Learning (APREXVER)	Inputs suppliers (equipment, raw materials); and customers.
Horizontal Learning (APREXHOR)	Competitors; and Other firms in the sector.
Learning through S&T institutions (APREXC&T)	Universities; and Research Institutions.
Learning through technical services (APREXSERESP)	Centers of Professional training, technical assistance and maintenance; Laboratories of tests and certification; and Consulting Enterprises.
Learning through other agents (APREXDEMAG)	Licenses patents and 'know-how"; Conferences, seminars, courses and technical publications; Fairs, Exhibitions and Shops; leisure meetings; local business associations; and network information base don Internet or computers.
Vertical cooperation (COOPVER)	Inputs suppliers (equipment, materials, components and software); and Customers.
Horizontal cooperation (COOPHOR)	Competitors; and other firms of the sector.
Cooperation with S&T institutions (COOPINSTC&T)	Universities; and Research institutes.
Cooperation with technical services (COOPSERESP)	Centers of Professional training, technical and maintenance assistance; laboratories of tests and certifications; and consulting enterprises.
Cooperation with other agents (COOPDMAG)	Representation; trade union entities; bodies of support and promotion; and financing agents.
3) Indicators of innovative performance	
Radical innovation in products (INRDPRD)	New product in the international market; and new product in the national market.
Radical innovation in processes (INRDPRC)	New process for the sector.
Incremental innovation in products (INICPRD)	New product for the firm, although existing in the market; Innovation in design of products; and creation of substantial improvement from the technological perspective of products packaging.
Incremental innovation in (INICPRC)	New technological processes for the firm, although existing in the sector.
Organizational innovations (INORG)	Advanced management techniques; changes in the organizational structure; changes in the concepts and/or practices of marketing; changes in the concepts and/ or practices of commercialization; amd implementation of new methods related to ISSO 9000/ 14000.

Source: Adapted from Stallivieri (2004) and Stallivieri, Campos and Britto (2007).

It should be noted that that the analysis is based on a self-evaluation by surveyed firms about the main factors that influenced their efforts for learning and the resulting process of capabilities building. This same kind of procedure was adopted for assessing the outcomes of these efforts, as well as the impacts perceived by the agents in terms of the process of capabilities building. Although recognizing that such kind of information gathering may distort results, once interviewee not always has the best understanding about what is being questioned, the procedure is fully recognized as adequate to analyses that deal with the processes of innovative capabilities building and is even mentioned as an important tool by OECD's Oslo Manual (2005) that establishes the methodological principles which have guided the Innovation Surveys in several countries.

Furthermore, the possibility of obtaining empirical data from different sources based on common methodologies and concepts tends to minimize problems related to the diversity of interpretation of questions among the agents.

In this sense, the conjunction of selected indicators allow for obtaining evidences on the dynamics of learning and on the construction of competencies in the scope of the surveyed LIPSs. With basis on these indicators, the procedures of *Multivariate Analysis* were applied aiming at, firstly, through the Factor Analysis, reducing the dimensions of the analysis[9]. Based on the factors identified for each set of indicators, it was sought to identify, by means of procedures related to *Cluster Analysis*[10], the specific behavior of groups of firms in relation to that dimensions, besides developing a *Discriminant / Classification Analysis* which the aim of establishing mechanisms for categorizing new enterprises according to patterns previously identified.

4. Structural characteristics of the studied clusters

In this section, two parallel efforts are carried out. At a first moment, the structural characteristics of the LIPSs are identified, and emphasis is given to some specificities of the local spaces where the productive activities occur, as well as to the peculiarities of the sample of firms, regarding the size of the establishments and their number of employees. Secondly, with basis on the indicators proposed, the general characteristics of the sample of firms with regard to those indicators are presented, highlighting the general indications about the processes of innovative effort, external learning and cooperative actions, and of innovative performance.

4.1. Structural characteristics of the studied clusters:

The following analysis use the information collected in five case studies of LIPS located in the state of Santa Catarina. One of the LIPS is associated to the electrical and metal-mechanical industry in the region of Joinville; two are related to the wood and furniture sector, in the Western region of the state and in the region of Porto Uniao; one is related to the plastics sector, in the Southern region of the state (Criciuma); and the last one is connected to the fishing sector, in the estuary of Itajai River.

Out of these arrangements, the most sophisticated from the structural point of view is that which is associated to the electrical and metal-mechanical industry, located in the region of Joinville. In this micro-region, nearly 30% of the workforce is employed in the electrical and metal-mechanical sector, with the participation of a large array of firms of varied sizes. The electrical and metal-mechanical arrangement shows a dense local productive structure and high heterogeneity in size of the firms, creating specializations by size of firm within the various groups of activities, including the manufacturing of machinery and equipment; office machines, computers and peripherals; electrical materials, devices and machines; medical and hospital equipment and instruments; equipment for industrial automation, as well as the manufacturing of metal products and the assemblage of motor vehicles, trailers and bodyworks. The information used in the study was obtained through field research within a stratified sample comprising 83 enterprises located in the municipalities of Joinville and Jaragua do Sul. The analysis of data collected from the enterprises of the electrical and metal-mechanical arrangement points to an intricate structure of internal relationships, which constitutes an evidence of the complex internal dynamics of operation of this cluster regarding the furtherance of interactive learning mechanisms able to strengthen the capabilities of local agents. There are also indications that different forms of cooperative actions are present in the arrangement, especially involving vertical relationships between customers and suppliers integrated into sub-contracting networks.

[9] The Factor Analysis is used for reducing the analytical dimensions, in the case of 23 indicators for some subjacent factors that allow a synthesis of the dimensions to be analyzed.

[10] For the 298 enterprises in the sample.

The specialized productive arrangement of plastics materials manufacturing is located in the South of Santa Catarina state, comprising a cluster of 66 enterprises, out of which 80% are small and medium enterprises dedicated to the production of plastic packaging and various plastic artifacts and disposables, and mainly concentrated in the municipalities of Criciuma, Orleans and São Ludgero. This productive arrangement had its beginning associated to the process of productive diversification introduced into the regional economy in the 1970s, when the main economic activity, the carbon industry, faces a process of economic slow-down which culminates in the 1990s. Although this crisis having brought about disastrous impacts on the regional economy, this latter got to positively react with the constitution of a productive fabric owed to investments made by the carbon industry owners in other productive activities, to the exploitation of local natural resources by entrepreneurs coming from other activities, to the creation of enterprises resulting from the process of production deverticalization etc. In the context of this process of productive diversification, the production of plastic materials begins to develop gradually and without previous planning. Concurrently, inputs suppliers are established in the region (for instance, paints and coloring), as well as suppliers of parts and components from the segments of mechanics, metallurgy and electric materials which provide support to the industry of plastic manufacturers in the cluster and to other industries such and clothing and ceramic.

The productive cluster of furniture manufacturing in the West of Santa Catarina state is mainly formed by micro and small enterprises dedicated to either mass or customized production of wood furniture. The Western region of Santa Catarina, specialized in furniture manufacturing comprises a total of 70 municipalities, where a total of 666 furniture manufacturers are concentrated, responding in the whole for 4,354 formal job posts according to data from RAIS-2003. The main municipalities in this region are Chapeco, Concordia, Xanxere, Xaxim and São Miguel do Oeste. The production is primary aimed at the national market, in the case of mass manufacturing, and for the local market in the case of customized production. The arrangement dedicated to the production of wood and its artifacts, located in the region of Vale do Iguaçu, in Santa Catarina, concentrates more than 300 firms in municipalities of the Northern region of Santa Catarina and of the Southeastern region of Parana State, specialized in the production and processing of wood, laminated wood, plywood and furniture, out of which nearly 90% are small and medium enterprises. In this region there are also about 80 enterprises that produce and supply inputs and equipment. These activities are considered the main source of income and employment in the region and had its expansion based on the exploitation of forest resources that are abundant in the LIPS. The main destinations of the LIPS's sales are concentrated in a few states of the country such as São Paulo, Parana and Rio Grande do Sul.

The productive arrangement specialized in fishing activities, located in the estuary of Itajai River and including the municipalities of Itajai and Navegantes, comprises three main activities: catching fish; processing and commercialization; and building and maintenance of fishing boats. The region is one of the main fishing poles in the country, accounting for more than 90% of the fishing production in the state. The segment of fish catching includes the major number of firms, with155 units (76.7% out of the total) in 2002. The processing segment employs the major number of workers (2,353), corresponding to 44.1% out of the total. Micro and small enterprises correspond to more than 96% of the total and are distributed throughout the three productive segments that comprise the arrangement, whereas medium and large sized enterprises are concentrated in the segments of processing and fishing boats.

Table 2 presents information regarding the sample of enterprises considered in the several studies whose outcomes are explored next. Altogether, for the set of five arrangements, the sample comprises 298 firms which employ almost 30 thousand workers. In terms of distribution of firms by size, a greater predominance of micro and small enterprises is observed in the arrangements of wood and furniture and of plastic materials. Yet, in terms of the number of employees, this participation is greater in the arrangement of furniture in the Western region and in that of plastics. The participation of firms of medium and large sizes is more significant in the arrangements of plastics industry and of electrical and metal-mechanical industry of Joinville. In terms of

participation in the total employment, these firms stand out in the arrangements of electrictal and meta-mechanical industry (especially the large firms), fishing (also the large firms) and of plastic materials (in this case, with major participation in employment of the medium enterprises).

Table 2 – General characteristics of the sample in the studied arrangements:

Clusters	Micro Enterprises				Small Enterprises				Medium Enterprises				Large Enterprises				Total	
	Establ.ishm.	% Establ.ishm.	Employees	% Employees	Establ.ishm.	% Establ.ishm.	Employees	% Employees	Establ.ishm.	% Establ.ishm.	Employees	% Employees	Establ.ishm.	% Establ.ishm.	Employees	% Employees	Establ.ishm.	Employees
Furniture in region West of Santa Catarina	40	59,7%	342	16,1%	24	35,8%	1106	52,0%	3	4,5%	678	31,9%	0	0,0%	0	0,0%	67	2126
Wood in the region of Vale do Iguaçú-SC	25	45,5%	249	8,4%	24	43,6%	899	30,4%	5	9,1%	876	29,7%	1	1,8%	930	31,5%	55	2954
Electrical and Metal-Mechanical in the Micro-region of Joinville - SC	37	44,6%	370	2,2%	34	41,0%	1565	9,3%	8	9,6%	1040	6,2%	4	4,8%	13914	82,4%	83	16889
Plastics in Region South of Santa Catarina	12	33,3%	182	3,8%	14	38,9%	822	17,3%	8	22,2%	2357	49,7%	2	5,6%	1384	29,2%	36	4745
Fishing in the region of the estuary of Itajaí River - SC	38	66,7%	479	18,7%	16	28,1%	704	27,4%	2	3,5%	385	15,0%	1	1,8%	1002	39,0%	57	2568
TOTAL	152	51,0%	1622	5,5%	112	37,6%	5096	17,4%	26	8,7%	5336	18,2%	8	2,7%	17230	58,8%	298	29282

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais (2004), own elaboration.

4.2 Analysis of indicators for the whole sample:

The data presented in Table 3, referring to the 298 enterprises inserted in the studied LIPSs, reveal that the strategies of the agents regarding the innovative effort are mainly concentrated on systematization and circulation of information obtained inside, once the indicators related to internal learning show the highest values: 0.65 for internal learning derived from other sources of information (area of production, area of marketing and commercialization, and customer service - APRINTDEMFONT), and 0.35 for the use of R&D department as source of information for innovation (APRINTP&D). Concurrently with this high importance related to the R&D department, we observe that this activities are accomplished in a low scale by firms in the sample, since the indicator related to the regularity in accomplishing R&D (CONSP&D) is low (0.19).

The enterprises of the studied LIPSs develop similar efforts regarding acquisition of new technologies (CONSNOVTEC), pre-innovative activities (CONSESPREINOV) and organizational updating (CONSATORG), once indicators present similar values: respectively 0.28 , 0.24 and 0.24. However, the low values attained by these indicators reflect that such activities are, in average, performed at a low scale by firms in the sample. Training efforts and human resources capabilities building, which can be described, in the ambit of the firms, by the indicators ESFTRERH and ESFABSRH, reflect respectively the efforts developed by firms for improving the capabilities of their workers and for absorbing qualified human resources. It is observed that, for the whole set of enterprises in these arrangements, the effort for training the workforce is reduced, with an indicator of 0.26, and that the absorption of qualified HR is still lower (0.14).

Table 3 – Descriptive statistics of indicators used (N = 298):

Indicators		Average	Variance	Standard deviation
Innovative Effort	Regularity in performing R&D (CONSP&D)	0,1913	0,0685	0,2617
	Regularity in acquisition of new technologies (CONSNOVTEC)	0,2844	0,0904	0,3006
	Regularity in pre-innovative effort (CONSESFPREINOV)	0,2433	0,0984	0,3138
	Regularity in organizational updating (CONSATORG)	0,2408	0,0898	0,2996
	Training effort (ESFTRERH)	0,2645	0,0595	0,2439
	HR Resources absorption effort (ESFABSRH)	0,1454	0,0477	0,2183
	Internal learning R&D department (APRINTP&D)	0,3549	0,1930	0,4393
	Internal Learning other sources (APRINTDEMFONT)	0,6523	0,1354	0,3679
External Learning and Cooperative Actions	Vertical Learning (APREXVER)	0,6341	0,1557	0,3946
	Horizontal Learning (APREXHOR)	0,3475	0,1091	0,3303
	Learning through S&T institutions (APREXC&T)	0,1092	0,0528	0,2297
	Learning through technical services (APREXSERESP)	0,1983	0,0606	0,2462
	Learning through other agents (APREXDEMAG)	0,4119	0,0733	0,2707
	Vertical cooperation (COOPVER)	0,2173	0,1292	0,3594
	Horizontal cooperation (COOPHOR)	0,1434	0,0686	0,2618
	Cooperation with S&T institutions (COOPINSTC&T)	0,0513	0,0311	0,1763
	Cooperation with technical services (COOPSERESP)	0,0394	0,0149	0,1221
	Cooperation with other agents (COOPDMAG)	0,0569	0,0151	0,1228
Innovative Performance	*Radical* innovation in products (INRDPRD)	0,1208	0,0763	0,2762
	Radical innovation in processes (INRDPRC)	0,1007	0,0908	0,3014
	Incremental innovation in products (INICPRD)	0,4452	0,1453	0,3812
	Incremental innovation in processes (INICPRC)	0,5503	0,2483	0,4983
	Organizational innovations (INORG)	0,3181	0,1002	0,3166

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais (2004), own elaboration.

Therefore, regarding the innovative effort, it is observed that the enterprises inserted in the studied LIPSs consider as most relevant for the innovative processes the strategies related to obtaining, systematizing and disseminating information acquired in the various departments of the firm, that is, the internal learning. Concurrently with this characteristic, a low effort towards technological updating is observed, and the actions aimed to acquisition of machinery and equipment, to pre-innovative activities and to organizational updating are considerably reduced. Generally, are equally reduced the actions related to training of HR and still lower the hiring of qualified personnel.

Indicators of external learning and cooperative actions reveal that the main form of interaction developed by firms in the sample refers to vertical learning. The value attained by the indicator of vertical external learning (APREXTVER = 0,63) denotes that information obtained with customers and suppliers is the most relevant for the innovative processes of these firms. Still regarding to external learning, it is noteworthy the relatively high value reached for information originated from other agents (APREXDEMAG), with an indicator of 0.41, parallelly to a little lower importance ascribed to information derived from competitors and other firms in the sector (APREXHOR) – 0.34. Also worth emphasizing is that the indicators that capture the relevance ascribed to information obtained from institutions of S&T (APREXC&T) and from technical services (APREXSERESP) show the lowest values among indicators of external learning (0.10 and 0.19, respectively), denoting the low importance attributed by firms in the sample to these sources of information.

Regarding cooperation, data corroborate that it occurs at a low scale for the average of firms in the sample, since all indicators related to that take values substantially reduced. The two outstanding forms of cooperation refer to vertical cooperation (COOPVER), which is restricted to cooperation with customers and suppliers, with an indicator of 0.21, and the horizontal cooperation

with competitors and other firms in the sector (COOPHOR), whose indicator shows an average value of 0.14. Indicators of cooperation with other agents (COOPDMAG), with institutions of S&T (COOPINTC&T) and with technical services (COOPSERESP), have the lowest values of all (0.05, 0.05, and 0.03 respectively).

With basis on indicators of external learning and cooperative actions, we perceive that there is a pattern regarding the interaction forms developed by firms in the sample. These latter attribute considerable importance to relationships of vertical character, prioritizing information exchanges with customers and suppliers. At a lesser scale, we note interactions developed with competitors and other firms in the sector, that is, of horizontal character. Nevertheless, the interactions developed with S&T institutions and with technical services are quite reduced, indicating that firms inserted in the studied LIPSs have much difficulty for interacting with this group of agents.

The indicators related to innovative performance reflect the average capacity of firms for introducing different kinds of innovations. Regarding innovations in products and processes, we note that most of the firms in question has high capacity for imitation, since indicators of incremental innovation in products (INICPRD) and incremental innovations in processes (INICPRC) reached the highest values (0.44 and 0.55, respectively). It is also observed a reasonable capacity of firms for introducing organizational innovations (INORG), since the indicator has a relatively high value (0.31).

Nevertheless, improvement of capabilities for introducing more "radical" innovations occurred at a low scale in the sample, as demonstrated by indicators. The indicator relative to the introduction of new products for the national and/or international market (INRDPRD) has a low value (0.12), denoting the low capacity of firms for innovating in this matter. The introduction of radical innovations in processes (INRDPRC) holds similar characteristics to the previous indicator, being equally reduced (0.10).

Thus, the analysis of indicators for the enterprises in the sample reveals that these latter concentrate their technological efforts on systematization of internal learning. The most relevant interactions are established with other productive agents, primarily with customers and suppliers and, at a lesser extent, with competitors and other firms in the sector. These enterprises have good ability for imitating products and processes and a reduced capacity for implementing more "radical" innovations. One can observe that the conjunction of innovative effort and the forms of interaction developed by firms reinforces this imitative character assumed by the innovative performance of the sample, as in a general manner the information obtained from the mentioned agents allow firms to implement improvements in their products and processes. However, the development of more intense activities for capabilities building, which could enable firms to implement more intense/ "radical" technological innovations, requires these firms to develop more intense efforts towards acquisition of new technology, development of pre-innovative activities and absorption of qualified HR, as well as to interact more intensively with S&T institutes and with agents that provide technical services.

A last issue worth stressing refers to the high heterogeneity of the studied firms, since a large number of indicators show a standard deviation either higher or very close to the own indicator's average, suggesting that the firms behave in manners that are significantly distinct regarding the dimensions captured by the indicators. This characteristic suggests the existence of different patterns of innovative effort, learning and cooperation processes and innovative performance of firms. Therefore, identifying such patterns in the enterprises of the sample implies, firstly, to reduce dimensions of analysis, in order to subsequently identify behavior patterns and shared characteristics.

5. The use of Multivariate Analysis techniques

The analysis developed in the previous section provided for the identification of (average) characteristics of firms in the sample regarding the indicators used in this work. Furthermore, it was possible to observe the high heterogeneity present in the sample, since many indicators presented a

standard deviation higher than their own mean, suggesting that firms have significantly distinct behaviors regarding the dimensions analyzed. Such characteristics lead us to propose the implementation of statistical mechanisms which allow identifying patterns in the processes of innovative effort, external learning and cooperative action, and innovative performance. For doing so, at a first moment procedures related to the *Factor Analysis* are used, seeking to systematize and reduce the relevant dimensions for analysis. Subsequently, in order to identify patterns present in the sample, we make use of *Cluster Analysis*, which will result in the identification of groups (clusters) of firms with similar behavior regarding the factors analyzed.

5.1 Extraction of underlying factors:

Based on the calculated indicators, it was sought to develop a *factor analysis*[11], through the method of *principal component*, making use of the option *varimax normalized*[12] for each subgroup of proposed indicators. The main purpose of *factor analysis* is to describe, if possible, the covariance relationships among many variables in terms of a few underlying factors that are not observable. Hence, the application of *factor analysis* will allow identifying the main factors and the weight of variables for each factor and, subsequently, characterizing the behavior of firms in the sample (taken as "cases" in the model) in relation to these factors. Initially, we seek to identify the main factors; in this perspective, Table 4 presents the *eigenvalues* for each factor and the percent of variance in data that is explained for each subgroup of indicators.

Tabela 4 – Eigenvalues and variance regarding selected factors (N = 298):

Indicators subgroup	Factor	Eigenvalue	% of total Variance explained	Cumul. Eigenvalue	% of cumul. Variance explained
Innovative Performance	Factor 1	2,251	45,028	2,251	45,028
	Factor 2	1,136	22,718	3,387	67,746
Innovative Effort	Factor 1	4,063	50,788	4,063	50,788
	Factor 2	1,123	14,039	5,186	64,828
	Factor 3	0,712	8,898	5,898	73,726
	Factor 4	0,617	7,708	6,515	81,433
External Learning and Cooperative Actions	Factor 1	3,867	38,666	3,867	38,666
	Factor 2	1,354	13,540	5,221	52,207
	Factor 3	1,175	11,751	6,396	63,958
	Factor 4	0,935	9,354	7,331	73,312

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais no Brasil (2004). Own elaboration based on STATISTICA 6.0 Software.

For the present study, we opted for applying three separate *factor analyses*, one for each subgroup of indicators. Concerning indicators of innovative performance, two (2) factors were chosen which together explain 67.74% of data variance. For the subgroup of indicators related to "innovative effort" four (4) factors were selected which explain 81.43% of total variance in data. Just like in the former subgroup, for indicators of "external learning and cooperative actions" also four (4) factors were selected which explain 73.31% of the variance. In both cases (indicators of innovative effort and indicators of external learning and cooperative actions), although eigenvalues of the third and fourth factors being[13] lesser than one (1), they were still used on the purpose of comprising the greater number as possible in the analysis, as well as for keeping a certain

[11] For the mathematical and statistical formalization of factor analysis, see Hair *et al* (2005) chap. 3, Malhotra (2001), Johnson and Wichern (1998), chap. 9.

[12] The method used in this work, besides being the most usual one, has a superior degree of "refinement", once it promotes the orthogonal rotation of the axis related to factors and variables (indicators), with the purpose of reaching the best possible result in fitting indicators to their respective factors.

[13] For indicators of external learning and cooperative actions, only the fourth factor has an eigenvalue lesser than 1.

representativeness of variance for these two subgroups[14]. The argument for these options is reinforced by the analysis of Tables A1 to A6 (in the Statistical Annex) which present, respectively the cumulative frequency[15] that explains the variance of each indicator (variable) by selected factors (A1, A2 and A3) and the factor loading[16] of each indicator, besides the new variance explained by the same factors[17] after the orthogonal rotation of the axes, for each subgroup of indicators suggested in this study (A4, A5, A6).

With basis on these data, it is possible to identify the characteristics of the factors used in the analysis. Table 5 presents a synthesis of information observed by the joint analysis of both factor loading matrix and the percent variance of each indicator explained by factors, thus facilitating the identification of the intrinsic characteristics of these factors in each subgroup of indicators. It was included in this table the factor loading of indicators which are most relevant for each factor.

Regarding the subgroup of indicators related to innovative performance, we noted that *Factor 1*[18] represents the indicators associated to the implementation of incremental innovations in products and processes (INICPRD and INICPRC) and to the implementation of organizational innovations (INORG). Thus, *Factor 1*, for this subgroup of indicators, can be named as factor of "incremental innovations". Factor 2 (that explains 30.31% of variance) can be named as the factor of "*radical* innovations", once it groups indicators related to radical innovation in products (INRDPRD) and radical innovation in processes (INRDPRC).

[14] According to Johnson and Wichern (1998), the least representativeness of variance by the whole set of selected factors for assuring the robustness of factor analysis refers to 65% of explanation for variance. In the analysis developed in this work, the least explained variance corresponds to 67.74%, which occurs in the case of innovative performance; hence, criteria for robustness of the analysis, as expressed in the technical literature, are met.

[15] The table on cumulative frequency reflects the percent of explained variance of each indicator by the factors used. That means, how much of the variance of an indicator is explained by one single factor, by two factors and so on. In the case of a same indicator to be associated to more than one factor, such indicator is referred to the factor which explains the major part of its variance

[16] The factor loading matrix represents the linear correlations between the different variable under analysis and its respective factors. These correlations can also be called saturations/ loads of the variables on the different factors. Thus, a factor assumes primarily the characteristics of the indicators with the major factor loading. In this study, we used a barrier regarding saturation of indicators in factors of 0.55 as indicated by Hair et al. (2005) for samples of this size.

[17] After an orthogonal rotation in the axes (method *varimax* normalized) the percent variance of data explained is changed (the total being unchanged) due to features of this method.

[18] Which explains 37,43% of variance (Table A4 – Statistical Annex).

Table 5 – Summarized characteristics of factors extracted for each subgroup of indicators:

Innovative Performance	
Incremental Innovations Factor	**"Radical" Innovations Factor**
?? Incremental Innovation in Products (INICPRD) – **0,84** ?? Incremental Innovation in Processes (INICPRC) – **0,79** ?? Organizational Innovations (INORG) – **0,70**	?? *Radical* Innovation in Products (INRDPRD) – **0,84** ?? *Radical* Innovation in Processes (INRDPRC) – **0,84**
Innovative Effort	
Technological and Organizational Updating Factor	**R&D Factor**
?? Regularity in Acquisition of New Technologies (CONSNOVTEC) – **0,85** ?? Regularity in Organizational Updating (CONSATORG) – **0,81**	?? Regularity in performing R&D (CONSP&D) – **0,86** ?? Internal Learning R&D Department (APRINTP&D) – **0,86**
Internal Learning Factor	**Pre-innovative Effort and Training Factor**
?? Internal Learning Other Sources (APRINTDEMFONT) – **0,90**	?? Effort for HR Absorption (ESFABSRH) – **0,83** ?? Training effort (ESFTRERH) – **0,71** ?? Regularity of Pre-innovative effort (CONSESFPREINOV) – **0,57**
External Learning and Cooperative Actions	
Factor of Learning through Productive Agents and with Other Agents	**Factor of Interaction with Technical Services**
?? Vertical Learning (APREXVER) – **0,80** ?? Learning with Other Agents (APREXDEMAG) – **0,79** ?? Horizontal Learning (APREXHOR) – **0,76**	?? Cooperation with Technical Services (COOPSERESP) – **0,84** ?? Cooperation with Other Agents (COOPDMAG) – **0,75** ?? Learning through Technical Services (APREXSERESP) – **0,61**
Factor of Interaction with Institutions of S&T	**Factor of Cooperation with Productive Agents**
?? Cooperation with institutions of S&T (COOPINSTC&T) – **0,84** ?? Learning through institutions of S&T (APREXC&T) – **0,82**	?? Horizontal Cooperation (COOPHOR) – **0,83** ?? Vertical Cooperation (COOPVER) – **0,58**

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais no Brasil (2004). Own elaboration, with basis on STATISTICA 6.0 Software.

For the subgroup of indicators of innovative effort, *Factor 1* (that explains 24.2% of variance) can be named factor of "technological and organizational updating" factor, once indicators referring to regularity in acquisition of new technology (CONSNOVTEC) and regularity in organizational updating (CONSATORG) represent a greater load in it, besides having the major part of their variance explained by this factor. Indicators referring to regularity in performing R&D (CONSP&D) and to internal learning associated to the department of R&D (APRINTP&D) have a load significantly higher in the *Factor 2*[19] of this subgroup; it, therefore, can be referred to as the "R&D Factor". *Factor 3* (which explains 13% of variance) is intensively affected by only one indicator, that one related to "internal learning through other sources"; thus, it can be designated as "factor of internal learning". At last, the forth factor of this subgroup gathers indicators related to the efforts of HR absorption (ESFABSRH), to the training efforts (ESFTRERH) and to regularity of pre-innovative efforts (CONSESFPREINOV). Thus, this factor[20] can be characterized as a "training and pre-innovative effort factor".

In the subgroup of external learning and cooperative actions' indicators, also four factors were selected. *Factor 1* (that explains 22.28% of variance) is mostly affected by the indicators that represent vertical learning (APREXVER), learning through other agents (APREXDEMAG) and horizontal learning (APREXHOR); thus, this factor may be called factor of "learning through productive and other agents". Indicators referring to cooperation with technical services (COOPSERESP), to cooperation with other agents (COOPDEMAG) and to learning through technical services (APREXSERESP) are affecting the second factor (responsible for explaining 20.52% of variance – Table A6 in the Statistical Annex); hence, this factor can be called "factor of

[19] That explains 21,38% of total variance (Table A5 – Statistical Annex).
[20] That explains 22,26% of total variance (Table A5 – Statistical Annex).

interaction with technical services". The third factor[21] can be called "factor of interaction with S&T institutions", once it groups indicators referring cooperation with institutions of S&T (COOPINSTC&T) and learning through institutions of S&T (APREXC&T). At last, the fourth identified factor (which explains 14.1% of variance – Table A6, Statistical Annex) is mostly influenced by indicators of horizontal cooperation (COOPHOR) and vertical cooperation (COOPVER), and can be considered as a "factor of cooperation with productive agents".

With regard to the factor loadings, it is worth highlighting that, excepting for the indicators presented for each factors, all remaining influence with low intensity the behavior of indicators. Something similar is observed regarding indicators which hold an inverse relation with factors that is in general very low (lesser than -0.1 – Statistical Annex, Tables A4, A% and A6) and have low influence over the final value of the factor. The analysis that follows aims at identifying the *factor scores*[22] related to the firms in the studied sample, thus allowing for, on the one hand, to proceed with comparative analyses and, on the other, to significantly reduce the number of variables to be considered, enabling the formation of clusters of firms with similar characteristics, without significant losses of freedom degrees in the analysis. Worth noting also, is that the characteristics inherent to each factor facilitate this kind of analysis, once these same factors have a rather clear meaning, as already described.

5.2 Application cluster analysis techniques:

This subsection aims at identifying similar patterns regarding the processes of innovative performance, innovative effort and external learning and cooperative actions among the firms comprising the group of five (5) studied LIPSs. In this perspective, we make use of *Cluster Analysis*[23], in order to identify the different groups (clusters) of firms with similar characteristics in terms of the identified factors[24]. The *cluster analysis* assesses a set of interdependent relationships among the cases, without distinguishing dependent from independent variables. It enables to classify objects – in this case, the firms in the sample – according to relatively homogeneous groups, based upon the set of variables, or, in case of the analysis in question, based upon a set of factors.

In order to assure "robustness" of the identified clusters, this analysis makes use of two methods of *clusterization*. Firstly, a method for hierarchical grouping (*neighbors-joining* method) was used for gaining an approximate idea about the number of clusters to be identified. At a second moment, a non-hierarchical clustering method, stipulating the number of clusters to be identified in the analysis.

Figure 1, obtained through the method of hierarchical clustering, where the distance between the cases (firms) are expressed, suggests the existence of 3 to 5 clusters of firms in the studied sample. From this analysis, and using the method of non-hierarchical clustering based upon the calculation of *K-means*, the sample was tested for 3, 4 and 5 clusters, respectively. The best results were obtained with three clusters, in which variables were more significant, and also presented a higher *F distribution* for most of the factors used[25]. Hence, we opted for grouping the firms according to three (3) different clusters.

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[21] Accounts for the explanation of 16,39% of variance (Table A6 – Statistical Annex).

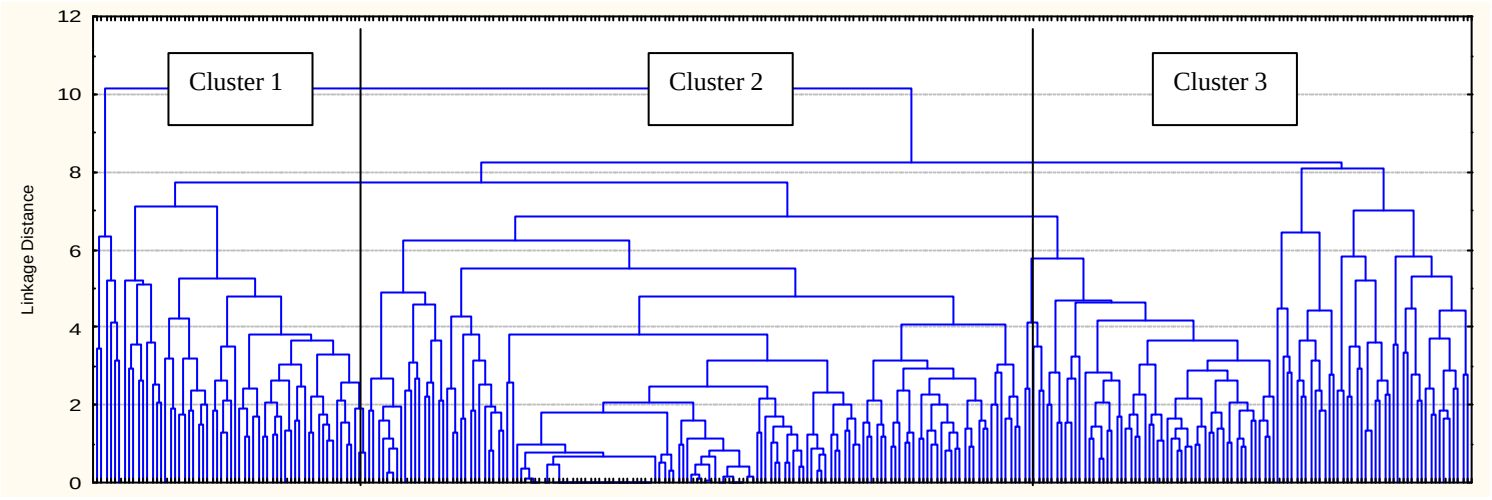
[22] The *score* is obtained from the factor coefficients related to each indicator. That is, the factor coefficients (presented in Tables A7, A8 and A9 – Statistical Annex) are multiplied by each indicator of the firms, resulting in a final value, corresponding to the individual factor *score* of the firm. The factor score corresponding to the first factor of the subgroup of innovative performance indicators, for instance, is obtained through the following equation: *Score Factor I – Incremental Innovations* = (-0,099)* INRDPRD + (-0,095)* INRDPRC + 0,49* INICPRD + 0,45*INICPRC + 0,35*INORG.

[23] See Johnson and Hair *et al* (2005), Malhotra (2001), Johnson and Wichern (1998).

[24] As already mentioned, it is assumed that the *factor score* referring to each firm in the identified factors.

[25] According to Johnson and Wichern (1998), a way for identifying, through the K-means clustering method, if an analysis with a different number of clusters is more effective, consists in comparing the *F* distances of variables in the different numbers of specified clusters. The *F distance* is equal to the quotient of the variable's variance among identified clusters by the variance of the same variable within each cluster. Thus, the greater this distance, the more the

Figure 1 – Tree clustering of firms comprising the studied LIPSs (N = 298):



Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais no Brasil (2004). Own elaboration based on STATISTICA 6.0 Software.

With basis on the results presented for 3 clusters (Table A9 – Statistical Annex), it is possible to claim that all factors used in the analysis contribute, at greater or lesser extent, to the formation of clusters (at a level of significance of 1% - *p value*). Another aspect worth noting (through the *F* distance) is that the factors which make the major contribution for the formation of clusters are, respectively: "Internal learning factor" (with *F* = 268.67); "Factor of learning through productive and other agents" (distance *F* = 183.47); "Factor of incremental innovations" (*F* = 129.64); and "Factor of radical innovations" (with distance F = 120.26). Nevertheless, it is important to emphasize that all factors affect the formation of clusters, thus assuring the existence of significant differences between the identified clusters.

Some inferences may be drawn regarding the distance between clusters from the conjoint analysis of Figure 2 and Table A11 (Statistical Annex). Table A11 presents the distance between clusters of firms, using the metrics of "the square of *Mahalanobis* distance", which measures the distance between the centroids of each cluster in a vector space with ten (10) dimensions[26]. Thus, the greater this distance, the more distant are the clusters.

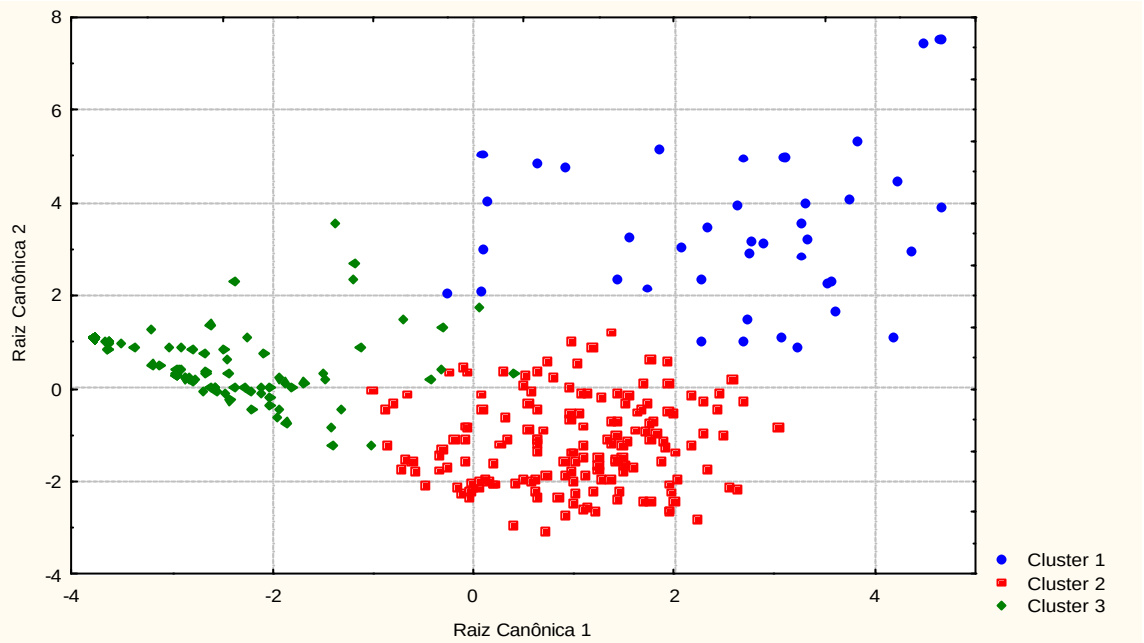
It is observed that the agglomerations grouped in clusters 2 and 3 present more similar patterns, once the distance separating them is shorter n(16.52). As for clusters 1 and 3, they have more distinct characteristics, because the distance between them is larger (35.12). These conclusions are reinforced by the analysis of Figure 2, where the ten factors identified are grouped into two canonical variables named "Canonical Roots[27]". Through the graphical analysis, it is perceived that the clusters are gathering the firms of the sample which share similar characteristics (commonalities), once in a general manner the closer cases are grouped within a same cluster.

clusters identified are distant and the more concise are these clusters. Therefore, the best number of clusters is that whose F values relative to variables are higher; these values are presented in Table A10 – Statistical Annex.

[26] Each dimension of this space refers to factors used in the analysis, in this case, ten.

[27] The Canonical roots provide an estimate of the amount of variance shared among the respective optimally weighted canonical variables. The canonical variables are linear combinations representing the weighted sum of two or more variables (in the case in question, of the tem factors). They can also be called linear combinations of the variables used in the analysis, thus reflecting their common characteristics (Hair *et al*, 2005).

Figure 2 – Dispersion chart of studied enterprises in relation to canonical roots (N = 298):



Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais no Brasil (2004). Own elaboration based on STATISTICA 6.0 Software.

In brief, therefore, the exercise developed in this section allow, at first, to reduce the dimensions of analysis from the twenty three (23) initially proposed indicators to ten (10) underlying factors, able of being interpreted, thus strengthening the analyzed dimensions. At a second stage, with basis on both the application of these factors to the 298 firms of the sample and the subsequent utilization of techniques for cluster analysis, three (3) patterns (clusters) of behaviors of firms in the sample, that is, three groupings of firms with similar characteristics regarding the analyzed dimensions.

6. Characterization of the identified patterns and development of mechanisms for classification of new enterprises

In the analysis developed in the former section, the existence of three patterns regarding the processes analyzed became evident. These patterns gather enterprises with similar characteristics. This section identifies, at a first moment, the specific characteristic of each pattern. Subsequently, a model for classification of new enterprises according to these three patterns previously identified is developed, seeking to provide elements for the characterization of new enterprises with basis on the identification of the dimensions stipulated in the present study.

6.1 Characterization of the patterns of innovative performance, innovative effort, external learning and cooperative actions of firms in the sample:

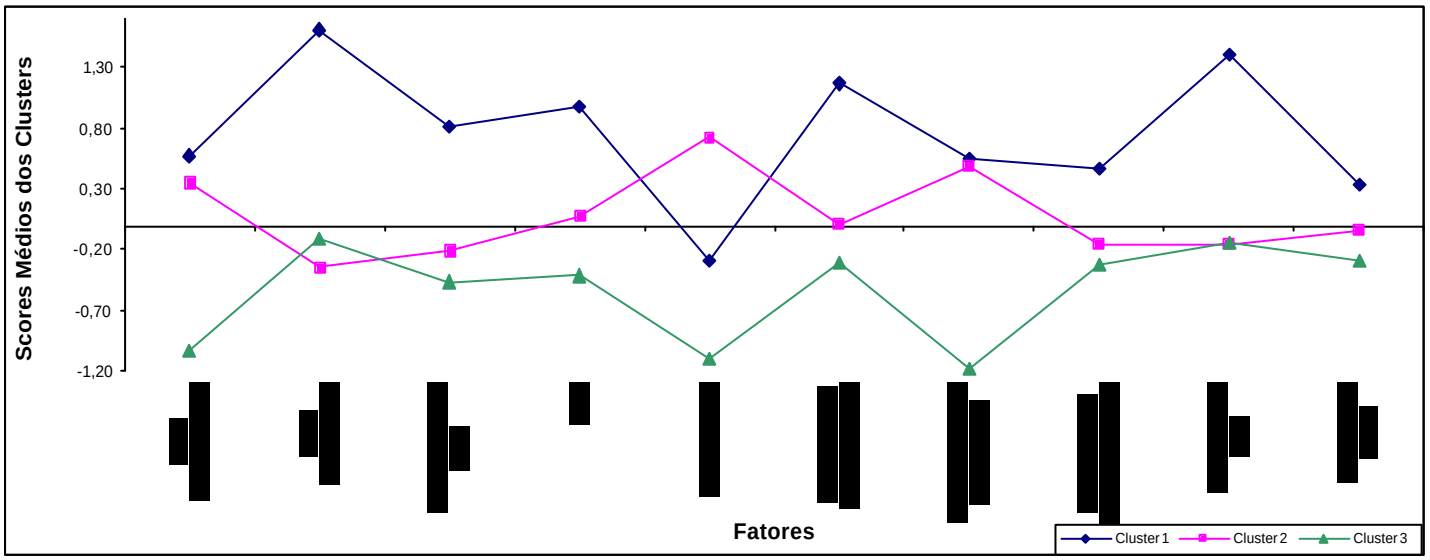
Until now, it was possible to identify the main factors related to indicators used in this work, as well as three groupings (clusters) of firms in the sample presenting similar characteristics regarding the factors analyzed. Figure 3 presents the values of factors identified for each cluster of firms. It is worth emphasizing that, for the whole sample, the average of a particular factor is always zero (0) and its standard deviation is equal to one (1) [28].

[28] The *Factor Analysis* has this characteristic; hence, the value obtained in a particular factor by a firm, or, in the current case, by a group of firms with similar characteristics can only be analyzed in comparative terms, with the average of the sample and with other groupings with similar characteristics. For further explanations, see Hair *et al* (2005).

The first cluster identified is comprised of 40 enterprises, being 22.5% of them micro enterprises; 37.5% small; 25% medium; and 15% are large. Regarding the spatial distribution of these firms, a predominance of the region of Joinville is perceived (which includes 70% of the firms), followed by the Western regions of the state and by the LIPS of plastic materials of the South of Santa Catarina (with 10% of the firms, each), by the region of Vale do Iguaçu (with 7.5% of the firms) and by Foz do Itajai (Itajai estuary) (with 2.5%). With basis on the values obtained in the several factors identified, we observe that this set of firms has a high innovative performance founded principally on the implementation of "radical[29]" innovations, that is, the introduction of new products in the national and international markets and of new processes in the sector of operation.

It is observed that these firms are those which carry out more innovative efforts, with emphasis to the implementation of strategies aimed at organizational and technological updating, R&D performing and carrying out of training and innovative efforts. They also develop more intensively actions related to external learning and cooperation. Learning through productive and other agents, interaction with technical services, cooperation with productive agents and interaction with institutions of S&T reach their greatest values in this cluster of firms, comparatively to the other identified clusters (2 and 3). Due to the characteristics presented by the first cluster of firms, namely: high scale of implementation of innovations (as much imitative as "radical"), intensive innovative effort (with emphasis in strategies related to HR training and performing of R&D) and high degree of external learning and cooperative actions; these firms could be designated as "enterprises with high innovative dynamism".

Figure 3 – Average values of factors analyzed in the identified clusters/ groupings of firms:



Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais no Brasil (2004). Own elaboration based on STATISTICA 6.0 Software.

The second group of firms (cluster 2) is comprised of 159 establishments[30], geographically distributed as follows: 39.6% in the Western region of Santa Catarina, 27.6% in the region of Joinville, 17.6% in the Southern region of the state, 13.1% in Vale do Iguaçu and 1.8% in Foz do Itajai. These enterprises hold an average innovative performance, mainly leaned on the imitation of products and processes. Their innovative effort is associated to the high intensity of systematization

[29] Besides the high intensity of "radical" innovations, these enterprises also do more intensive introduction of incremental innovations.

[30] Being 46.5% of them micro enterprises, 44% small enterprises, 8.1% medium and 1.2% large.

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and dissemination of information internally obtained, and the factor related to internal learning reaches in this cluster the greatest values among identified patterns.

The strategies related to external learning and cooperation actions are mainly concentrated on learning through productive and other agents, implying that for this group of firms the interaction rather occurs within the productive relationships, including customers, suppliers, competitors and other firms in the sector. These firms, grouped in cluster 2, can be designated as "enterprises with medium innovative dynamism", once they share the characteristics of implementing incremental innovations, having a high level of internal learning and a reasonable interaction with productive and other agents.

Out of the 99 firms grouped[31] in the third cluster, we observe that 69.7% are micro enterprises, 27.2% are small and 3% are medium enterprises. In view of the characteristics presented regarding the factors analyzed, this cluster refers to "enterprises with low innovative dynamism". Such low dynamism is manifested by the little introduction of innovations, as much imitative as those "radical". The innovative effort also occurs at a low scale in these enterprises, with their main strategy consisting of training and pre-innovative efforts. The relationships regarding external learning and cooperation are quite reduced, indicating that these firms have a very low scale of interaction with the whole of agents captured by the indicators proposed in this work. In view of these characteristics, the low innovative dynamism of this group of firms seems to be a consequence of the low innovative effort and, principally, of the absence, on the part of these firms, of innovative interactions with agents which comprise the local /regional geographical spaces. Table 6 aims to present a comparative analysis of the identified groups of firms.

Table 6 – Comparative analysis of identified clusters:

Characteristics / *Clusters*	**Cluster 1 (99 firms) "Enterprise with high innovative dynamism"**	**Cluster 2 (159 firms) "Enterprise with medium innovative dynamism"**	**Cluster 3 (99 firms) "Enterprise with low innovative dynamism"**
Innovative Performance	High; emphasis on the introduction of "radical" innovations	Medium; leaned on the introduction of incremental innovations	Low, as much in introduction of incremental innovations as of "radical" ones.
Innovative Effort	High; emphasis on R&D, technological updating and training	Medium; emphasis on internal learning	Low; innovative efforts made at a very reduced scale.
External Learning and Cooperative Actions	High; emphasis on the interaction with institutions of S&T	Medium; the main form of interaction happens with productive agents	Low; absence of interaction with agents in the arrangement.

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais (2004), own elaboration.

Regarding the "enterprise with high innovative dynamism", it is observed that both this high innovative effort and the development, at a high scale, of external learning and cooperation relationships generate capabilities that enable these enterprises to innovate. Still regarding this group, worth highlighting is the strong interaction with institutions of S&T, a fact that opens opportunities for these firms to introduce more "radical" innovations. The enterprises of *cluster 2* – "enterprises with medium innovative dynamism" – concentrate their innovative efforts on internal learning, developing external learning relationships mainly with other productive agents. Such characteristics generate capabilities for these firms to implement innovations of an incremental character, related to imitation of products and processes. Finally, the low innovative effort, added to the lack of interactions with other agents in the region (agents that belong to the arrangement), restrains the development of innovative capabilities by "enterprises with low innovative dynamism"

[31] Geographically distributed as follows: 53.5% in the region of Foz do Itajaí, 31.3% in Vale do Iguaçú, 11.1% in Joinville region and 4% in the South of Santa Catarina state..

(cluster 3) so that their scale of introduction of both incremental and "radical" innovations is very low.

6.2. A model for classifying new enterprises:

With basis on the former subsection, it was possible to identify the intrinsic characteristics of each group (cluster) of firms which comprise the sample. Following to this characterization, we suggested some procedures which allow categorizing new enterprises according to predefined patterns. This analysis provides elements for the previous identification of patterns referring to the new enterprises, thus facilitating the process of data collecting[32] and the subsequent proposal of specific policies for the firms, according to those patterns. In doing so, we make use of discriminant analysis[33] and of a classification function[34].

Table 7 presents the results obtained through the discriminant analysis, in terms of statistical significance and of *Wilks' Lambda*. We can observe that all factors are statistically significant for the discrimination of the clusters. With basis on Wilkis' Lambda, we observe that the factors for "internal learning", "radical innovations" and "interaction with institutions of S&T" are those which most contribute for discriminating the identified groups. Through this analysis, we note that the discrimination of clusters based on the used factors generates good results, once at a greater or lesser extent all factors are affecting the discrimination of patterns (clusters).

Table 7 – Discriminant Analysis for the three identified clusters (N = 298):

Factors	**Wilks' Lambda**	**Partial Lambda**	**Tolerance**	**Minimum Tolerance**
Factor of Incremental Innovations	0,066*	0,937	0,645	0,355
Factor of "Radical" Innovations	0,087*	0,714	0,874	0,126
Factor of Technological and Organizational Updating	0,065*	0,952	0,626	0,374
Factor of R&D	0,069*	0,904	0,677	0,323
Factor of Internal Learning	0,094*	0,656	0,818	0,182
Factor of Training and Pre-innovative Effort	0,065*	0,953	0,645	0,355
Factor of Learning through Productive and Other Agents	0,069*	0,903	0,756	0,244
Factor of Interaction with Technical Services	0,067*	0,923	0,865	0,135
Factor of Interaction with Institutions of S&T	0,079*	0,789	0,852	0,148
Factor of Cooperation with Productive Agents	0,066*	0,945	0,937	0,063

Global Wilk's Lambda = 0,0619
F Test (20,57) = 86,29
* Significant at 1%, ** Significant at 5%; NS = non significant.
Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais no Brasil (2004). Own elaboration with basis on STATISTICA 6.0 Software.

Table 7 describes the classification functions stipulated for each of the three described patterns. It is observed that the coefficients related to each factor express the specificities of the

[32] Because the dimensions for classification of new enterprises according to the three identified patterns refer to indicators that comprise the ten factors, Due to this characteristic, the process of data collecting, that is, of field research with new enterprises, is facilitated once the dimensions to be captured are already well defined and substantially reduced.

[33] The fundamental purpose of Discriminant Analysis is to estimate the relation between a non metric dependent variable (categorical – in the case in question, the three identified clusters) and a set of metric independent variables (in this case, the ten factors) (Hair et al., 2005).

[34] Method for classification where a linear function is defined for each group under analysis (3 clusters). Worth highlighting is that the classification occurs through the calculation of a score for each observation in the classification function for each group and, subsequently, designating the observation to the group with greater score.

groups, once the greater the coefficient of the factor in a particular cluster, the more influent is this characteristic for the classification of the events. Regarding cluster 1, the data analysis strengthen the characteristics previously described, once the factor related to "radical innovations" has the highest coefficient (3.77), that is, it is the main determinant for a firm to be inserted in this pattern. For this cluster, excepting for "internal learning[35]", all other factor have positive coefficients, indicating the direct relation between them and the firms allocated in this pattern. Still in relation to cluster 1, we should highlight the high values attained by the coefficients related to factors of "interactions with institutions of S&T" (2.86), "R&D" (2.34) and "interaction with technical services", a fact that exposes the relevance of these activities for firms to be classified in this pattern. These latter characteristics also reinforce the existence of a direct relation between interactions with institutions of S&T, R&D activities and technical services, and the innovative performance by the firms expressed through the introduction of innovations of a rather "radical" character.

Table 8 – Classification functions of the three clusters identified with basis on the factors analyzed (N = 298):

Factors	**Cluster 1 probab. = 0,134**	**Cluster 2 probab. = 0,533**	**Cluster 3 probab. = 0,332**
Factor of Incremental Innovations	0,154	0,645	-1,352
Factor of "Radical" Innovations	3,779	-0,712	-0,436
Factor of Technological and Organizational Updating	1,540	-0,213	-0,844
Factor of R&D	2,346	0,052	-0,806
Factor of Internal Learning	-0,027	1,764	-2,980
Factor of Training and Pre-innovative Effort	1,557	0,037	-0,370
Factor of Learning through Productive and Other Agents	0,784	0,540	-1,691
Factor of Interaction with Technical Services	1,742	-0,304	-0,955
Factor of Interaction with Institutions of S&T	2,869	-0,478	-0,376
Factor of Cooperation with Productive Agents	0,533	0,165	-0,918
Intercept	-10,537	-1,733	-5,199

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais no Brasil (2004). Own elaboration with basis on STATISTICA 6.0 Software

For the second pattern identified (cluster 2), the classification function reveals that the main factor affecting the entry or not of a firm in this group refer to "internal learning", which has the highest coefficient for this group (1.76). Still regarding this group, the emphasis are put on the factors of "incremental innovations" (0.64) and "learning through productive and other agents" (0.54). It is observed that the factors related to "radical innovations", "interactions with institutions of S&T", interactions with technical services" and "technological and organizational updating" show negative coefficients in the classification function of this cluster. Given the values and signs of coefficients related to the various factors, we note that in this cluster the internal learning effort and the development of learning actions with productive and other agents improve the capabilities of firms for imitating products and processes, that is, for fulfilling incremental innovations generating a medium innovative performance leaned on the introduction of this kind of innovation. Finally, regarding cluster 3, we observe that all coefficients related to the factors exhibit negative signs, a fact that indicates the low innovative dynamism of firms inserted in this pattern.

After stipulating the three classification functions referring to each pre-identified pattern, we must test the efficiency of the proposed method. In this perspective, Table 9 presents the classification matrix obtained with the functions stipulated for the sample of enterprises. The data presented corroborate the efficiency of stipulated functions, once we obtained, based on the

[35] Which, in general, is high for all firms in the sample, as demonstrated in section 4.

proposed method, 96.13% of accuracy in classification of the cases (enterprises); that is, by applying the respective classifications functions to the sample in question, most of the cases were correctly classified in their respective clusters.

Table 9 – Classification matrix of firms in the identified clusters (N = 298):

Observed / Estimated	Percent of the Model's accuracy	Cluster 1	Cluster 2	Cluster 3	Total
Cluster 1	90,00	36	2	2	40
Cluster 2	99,37	0	158	1	159
Cluster 3	93,94	0	6	93	99
Total	96,31	36	166	96	298

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais no Brasil (2004). Own elaboration with basis on STATISTICA 6.0 Software

It is observed, therefore, that the method proposed in this subsection was effective for the classification of enterprises in the identified groups. In view of the good results attained, it is possible to apply these same functions to the study of new enterprises, thus allowing their classification, with basis on less data collected through field research, into one of the three already identified patterns (clusters). This process can be used for proposing specific regional policies aimed at stimulating productive and innovative capabilities of local agents. Furthermore, the policies suggested for each of the clusters can be extended to new enterprises that present characteristics similar to those of the group in question.

7. FINAL REMARKS

The analysis carried on was based on the treatment of a set of questions aimed at providing some kind of mensuration of innovative efforts and performance, as well as of the importance of external learning and cooperative actions between agents in the ambit of local productive arrangements. The exercise proposed in this work was based upon the use of indicators and on the subsequent application of techniques of Multivariate Analysis (factor analysis, cluster analysis and discriminant / classification analysis), on the purpose of identifying groups of agents with similar characteristics regarding factors which express those aspects. The analysis carried on allowed identifying three clusters of enterprises with similar patterns regarding the characteristics of innovative performance, innovative effort and external learning and cooperative actions. It also allowed developing a model for classification of new enterprises according to the identified patterns, which obtained a high degree of accuracy.

It is observed that the identified clusters can be characterized according to the innovative dynamism of the firms that integrate it. In this sense, the first cluster was named "enterprises with high innovative dynamism", once the firms inserted in it are those which more intensively introduce innovations and carry on activities related to innovative effort and strategies related to external learning and cooperative actions. The second cluster of firms that was identified refers to "enterprises with medium innovative dynamism", once they introduce mainly incremental innovations, showing high capacity for imitating products and processes. Their learning efforts consist in the systematization of information internally generated (internal learning) and their interactive learning is mainly related to the exchange of information with other productive agents. Finally, the third cluster gathers the "enterprises with low innovative dynamism" which introduce innovations (as much "radical" as incremental) at a very low scale, being also reduced their actions related to innovative effort and to external learning and cooperation.

Regarding the development of capabilities that enable enterprises to innovate, we can draw some conclusions in view of the analysis here developed. As a consequence of the analysis, we observe that the development of more dynamic capabilities which lead firms to introduce more

"radical" innovations (new products for the national and international markets, and new processes for the sector of operation) derives from the development of strategies through which the enterprises raise their innovative efforts related to the execution of R&D, and also develop interactions with institutions of S&T and with technical services (laboratories of certification and training centers, for instance). On the other hand, the possibility of firms to implement incremental innovations (imitation of products and processes) is mainly related to a greater systematization of information obtained in the various departments of the firm (internal learning) and to development of interactions with other productive agents (customers, suppliers, competitors and other firms in the sector).

Hence, both the public and the private actions, in the scope of the analyzed LIPSs, should focus principally these factors, in order to raise innovative capacity of firms. The promotion of these actions would allow for both qualitative and quantitative advancements of innovative dynamism of the arrangements, once they could make less dynamic enterprises (those from cluster 3, for instance) to improve their capabilities for imitating products and processes, and the enterprises with medium innovative dynamism to develop capabilities for innovating in a more radical way. In this perspective, the model for classification of new enterprises presented in this work, which attained a accuracy rate of 96.31%, can help the identification of new firms and their subsequent adjustment to the pre-identified patterns with basis on an amount of information significantly reduced. The application of this model can lead to the implementation of strategies qualitatively higher for supporting enterprises within LIPSs, once it allows defining actions aimed to particular groups of enterprises, seeking to generate a greater innovative capacity in them.

Still worth emphasizing is that the proposed methodology provides an objective contribution to the characterization of the "innovative dynamics" of those arrangements, understood as a process of permanent evolution and transformation. Particularly, it is possible to claim that the innovative dynamics of each arrangement tend to be strongly influenced by the relative participation of its enterprises in each one of the identified clusters. From this analysis, it is also possible to suggest that the possibilities for a particular arrangement to evolve along a "virtuous" trajectory in strengthening innovative capacity would be directly articulated to the mode as the configuration of the various groups of agents that integrate it evolves. From the methodological point of view, this kind of analysis is articulated is connected with two other research fields that have been explored in the debates on the innovative dynamics of local productive arrangements: (i) analyses of typological nature on the patterns of governance that characterize these arrangements (Campos *et a*l., 2005; Cassiolato and Szapiro, 2003); (ii) attempts for identifying a nucleus of dynamic enterprises that stimulate the increment of innovative capabilities in the ambit of these arrangements (Stallivieri *et al*, 2005 and 2007).

At last, it is important to mention, as well, some possible consequences of the analysis carried on. Such analysis comprises a broader research program that aims at identifying and analyzing indicators related to the "innovative dynamics" that characterizes local productive arrangements. In this perspective, and in terms of a future research agenda, in order to advance beyond the accomplished analysis, some additional steps are necessary. First of all, it becomes necessary a more detailed analysis of both the structural conformation of those agglomerations and the degree of density of their internal relationships. An intertemporal analysis of the evolutive trajectory of these agglomerations would also be interesting, so that to capture their greater or lesser dynamism and the impacts resulting in terms of their internal configuration, which could be confronted with information regarding the rates of variation in intensity of cooperative relationships, as well as the innovative efforts and performance of investigated activities.

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ANNEXES:

Methodological Annex I – Questions used for elaborating the indicators:

1. What was the action of your enterprise **in the period from 2000 to 2002** regarding the **introduction of innovations**? Please state the main characteristics as listed below (please note in Box 1 the concepts of **new** products/processes or **significantly improved** products/processes, so that to help you to identify the kind of innovation introduced).

Description	**1. Yes**	**2. No**
Product Innovations		
New product for your enterprise, though existing in the market?	(1)	(2)
New product for the national market?	(1)	(2)
New product for the international market?	(1)	(2)
Innovations in processes		
New technological processes for your enterprise, though existing in the sector?	(1)	(2)
New technological processes for the sector of operation?	(1)	(2)
Other kinds of innovation		
Creation or substantial improvement, from the technological perspective, of the form of packaging products (packing)?	(1)	(2)
Innovations in the design of products?	(1)	(2)
Accomplishment of organizational changes (organizational innovations)		
Implementation of advanced management techniques?	(1)	(2)
Implementation of significant changes in the organizational structure?	(1)	(2)
Significant changes in marketing concepts and/or practices?	(1)	(2)
Significant changes in commercialization concepts and/or practices?	(1)	(2)
Implementation of new methods and management, aiming to meet certification norms (ISO 9000, ISSO 14000, etc.)?	(1)	(2)

2. What **kind of innovative activity** did your firm develop **in 2002**? Please indicate the degree of regularity dedicated to the activity by marking (0) if did not develop, (1) if it was developed on a routine basis, and (2) if it was developed occasionally. (Please observe in Box 2 the description of the kind of activity).

Description	**Regularity Degree**		
Research and Development within your firm.	(0)	(1)	(2)
Acquisition of external R&D	(0)	(1)	(2)
Acquisition of machinery and equipment hat implied significant technological improvement in products/processes or that are associated to new products/ processes.	(0)	(1)	(2)
Acquisition of other technologies (software, licenses or agreements for technology transference, such as patents, trade marks and trade secrets)	(0)	(1)	(2)
Industrial project or industrial design associated to product/ processes either technologically new or significantly improved.	(0)	(1)	(2)
Training program aimed to the introduction of technologically new or significantly improved products/processes.	(0)	(1)	(2)
Programs on quality management or organizational modernization, such as: total quality, reengineering of administrative processes, deverticalization of the productive process, *just in time* methods etc.	(0)	(1)	(2)
New ways of commercialization and distribution in the market of either new or significantly improved products.	(0)	(1)	(2)

3. Did your firm carry on human resources **training and capabilities building** activities **during the latter three years, 2000 to 2002**? Please indicate the degree of relevance by using the scale below, where 1 means low relevance, 2 means medium relevance and three means high relevance. Choose 0 if it was not relevant for your firm.

Description	**Relevance Degree**			
Inhouse Training	(0)	(1)	(2)	(3)
Training through technical courses carried on within the arrangement	(0)	(1)	(2)	(3)
Training through technical courses outside the arrangement	(0)	(1)	(2)	(3)
Internships at either supplier or customer enterprises	(0)	(1)	(2)	(3)
Internships at enterprises of the group	(0)	(1)	(2)	(3)
Hiring of technicians/ engineers from other enterprises in the arrangement	(0)	(1)	(2)	(3)
Hiring of technicians / engineers from enterprises outside the arrangement	(0)	(1)	(2)	(3)
Absorption of graduates from universities located within or near the arrangement	(0)	(1)	(2)	(3)
Absorption of graduates from technical located within or near the arrangement	(0)	(1)	(2)	(3)

4. Which of the following items did play a relevant role as a **source of information for learning, during the latter three years, 2000 to 2002**? Please indicate the degree of relevance by using the scale below, where 1 means low relevance, 2 means medium relevance and three means high relevance. Choose 0 if it was not relevant for your firm. Please indicate the **formal status** by using 1 for formal and 2 for informal. As for the **localization**, use 1 if located within the arrangement, 2 in the state, 3 in Brazil, and 4 if abroad. (Please observe in Box 3 the concepts on modes of learning.)

	Degree of Relevance				**Formal status**		**Localization**			
Internal sources										
Department of R&D	(0)	(1)	(2)	(3)	(1)	(2)				
Production Area	(0)	(1)	(2)	(3)	(1)	(2)				
Marketing, sales and customer services areas	(0)	(1)	(2)	(3)	(1)	(2)				
Other (please quote)	(0)	(1)	(2)	(3)	(1)	(2)				
External sources										
Other firms within the group	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Associated firms (joint ventures)	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Inputs suppliers (equipment, materials)	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Customers	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Competitors	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Other firms in the Sector	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Consultant Services Firms	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Universities and Other Research Institutes										
Universities	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Research Institutes	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Centers of Professional training/ education, of technical assistance and maintenance services.	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Laboratories of tests and certifications	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Other sources of information										
Licenses, patents and *know-how*	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Conferences, Seminars, Courses and Technical Publications	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Trade Fairs, Exhibitions and Shops	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Leisure meetings (Clubs, Restaurants, etc.)	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Local business associations (including exports consortia)	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Network information based upon Internet or computer	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)

5. In the affirmative case, which of the following agents did play a **relevant role as partners during the latter three years, 2000 to 2002**? Please indicate the degree of relevance by using the scale below, where 1 means low relevance, 2 means medium relevance and 3 means high relevance. Choose 0 if it is not relevant for your firm. Please indicate the **formal status** by using 1 for formal and 2 for informal. As for the **localization**, use 1 if located within the arrangement, 2 in the state, 3 in Brazil and 4 if abroad.

Agents	**Relevance**				**Formal status**		**Localization**			
Enterprises										
Other enterprises within the group	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Associated firms (joint venture)	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Inputs suppliers (equipment, materials)	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Customers	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Competitors	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Other firms in the Sector	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Consultant Services Firms	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Universities and Other Research Institutes										
Universities	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Research Institutes	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Centers of Professional training/ education, of technical assistance and maintenance services.	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Laboratories of tests and certifications	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Other Agents										
Representations	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Trade union entities	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Other entities of support and promotion	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)
Financial Agents	(0)	(1)	(2)	(3)	(1)	(2)	(1)	(2)	(3)	(4)

Methodological Annex II – Mathematics of indicators:

With regard to the mathematical formalization of indicators, it is worth noting that indicators that seek to assess the relevance ascribed by agents to a particular event, as the indicators of learning (internal - APRINTP&D and APRINTDEMFONT – and external – APREXVER, APREXHOR, APREXC&T, APREXSERESP, APRINTDEMFONT), cooperation (COOPVER, COOPHOR, COOPINSTC&T, COOPSERESP and COOPDMAG), training efforts and HR absorption (ESFTRERH e ESFABSRH), are measured in a similar way, as follows:

$$I_{i,j} = \frac{1}{k} \sum_{l=1}^{k} \frac{n_{i,l}}{3}$$

where j represents each set of agents or events that constitutes an indicator; $k = 1,2,...,\boldsymbol{n}$ is the number of agents grouped in each set; and $i = 1,2,...,n$ are the firms.

Indicators referring to "regularity of innovative activities" (CONSP&D, CONSNOVTEC, CONSESFPREINOV and CONSATORG) were formalized as follows:

$$COATINV_i = \frac{1}{k} \sum_{l=1}^{k} \bar{g}_{i,l} \quad \ldots \begin{cases} 1 \text{ se } g_{i,l} = 1 \\ \bar{g}_{i,l} \quad \text{se } g_{i,l} = 2 \\ 0 \text{ c.c.} \end{cases}$$

, where $g_{i,l}$ is the answer of each agent in relation to each event (innovative activity). Where 1 represents regularity; 2 represents occasionality; and 0 represents that no innovative activity is developed.

Finally, indicators regarding the innovative performance of agents (INRDPRD, INRDPRC, INICPRD, INICPRC and INORG) follow the logic as set below:

$$INOV_i = \frac{1}{k} \sum_{l=1}^{k} \bar{I}_{i,l} \quad ; \quad \bar{I}_{i,l} = \begin{cases} 1 \text{ se } I_{i,l} = 1 \\ 0 \text{ se } I_{i,l} = 2 \end{cases}$$

, where $I_{i,l}$ is the answer of agent regarding the kind of innovation introduced. Where 1 means that an innovation was introduced and 0 means that no innovation was introduced.

Once more, it is worth noting that these indicators were, at a first moment, individually built for each enterprise inserted in the studied LIPSs. It is also easy to see that, by following the proposed formulas, all indicators take values that range from 0 to 1, and that the closer to 1 the more agents get near a more virtuous situation.

Statistical Annex:

Table A1 – Cumulative Variance of Indicators Explained by the Analyzed Underlying Factors – Subgroup of Indicators of Innovative Performance (N=298):

Indicators / % of Explained Variance	With 1 Factor	With 2 Factors
Radical Innovation in Products (INRDPRD)	0,016	0,724
Radical Innovation in Processes (INRDPRC)	0,018	0,734
Incremental Innovation in Products (INICPRD)	0,708	0,710
Incremental Innovation in Processes (INICPRC)	0,635	0,645
Organizational Innovations (INORG)	0,495	0,575

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais (2004), own elaboration.

Table A2 – Cumulative Variances of Indicators Explained by the Analyzed Underlying Facotrs – Subgroup of Innovative Efforts Indicators (N=298):

Indicators / % of Explained Variance	With 1 Factor	With 2 Factors	With 3 Factors	With 4 Factors
Regularity in execution of R&D (CONSP&D)	0,041	0,789	0,790	0,856
Regularity in Acquisition of New Technologies (CONSNOVTEC)	0,731	0,755	0,778	0,801
Regularity in Pre-Innovative Effort (CONSESFPREINOV)	0,325	0,372	0,373	0,705
Regularity in Organizational Updating (CONSATORG)	0,663	0,669	0,691	0,764
Training Effort (ESFTRERH)	0,096	0,127	0,255	0,766
Effort for HR Absorption (ESFABSRH)	0,035	0,097	0,113	0,816
Internal Learning R&D Department (APRINTP&D)	0,006	0,756	0,832	0,856
Internal Learning Other Sources (APRINTDEMFONT)	0,038	0,081	0,903	0,951

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais (2004), own elaboration.

Table A3 – Cumulative Variances of Indicators Explained by the Analyzed Underlying Factors – Subgroup of External Learning and Cooperative Actions Indicators (N=298):

Indicators / % of Explained Variance	With 1 Factor	With 2 Factors	With 3 Factors	With 4 Factors
Vertical Learning (APREXVER)	0,654	0,676	0,690	0,692
Horizontal Learning (APREXHOR)	0,580	0,583	0,584	0,688
Learning through Institutions of Science and Technology (APREXC&T)	0,062	0,091	0,766	0,769
Learning through Technical Services (APREXSERESP)	0,217	0,601	0,711	0,751
Learning through Other Agents (APREXDEMAG)	0,626	0,691	0,719	0,725
Vertical Cooperation (COOPVER)	0,037	0,254	0,323	0,669
Horizontal Cooperation (COOPHOR)	0,027	0,070	0,075	0,772
Cooperation with Institutions of S&T (COOPINSTC&T)	0,001	0,001	0,721	0,800
Cooperation with Technical Services (COOPSERESP)	0,000	0,713	0,729	0,773
Cooperation with Other Agents (COOPDMAG)	0,025	0,601	0,603	0,692

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais (2004), own elaboration.

Table A4 – Matrix of Factor Loading of Indicators on the Respective Factors and Explained Variance after Orthogonal Rotation of the Axes – Subgroup of Innovative Performance Indicators (N=298):

Indicators	Factor 1	Factor 2
Radical Innovation in Products (INRDPRD)	0,126	0,842
Radical Innovation in Processes (INRDPRC)	0,133	0,846
Incremental Innovation in Products (INICPRD)	0,842	0,038
Incremental Innovation in Processes (INICPRC)	0,797	0,099
Organizational Innovations (INORG)	0,703	0,282
Explanation of Variance	0,374	0,303

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais (2004), own elaboration.

Table A5 – Matrix of Factor Loading of Indicators on the Respective Factors and Explained Variance after Orthogonal Rotation of the Axes – Subgroup of Innovative Effort Indicators (N=298):

Indicators	Factor 1	Factor 2	Factor 3	Factor 4
Regularity in execution of R&D (CONSP&D)	0,203	0,865	0,020	0,258
Regularity in Acquisitionof New Technologies (CONSNOVTEC)	0,855	0,156	0,150	0,152
Regularity in Pre-Innovative Effort (CONSESFPREINOV)	0,570	0,218	0,010	0,507
Regularity in Organizational Updating (CONSATORG)	0,814	0,078	0,149	0,269
Training Effort (ESFTRERH)	0,310	0,175	0,358	0,715
Effort for HR Absorption (ESFABSRH)	0,188	0,249	0,126	0,839
Internal Learning R&D Department (APRINTP&D)	0,078	0,866	0,275	0,156
Internal Learning Other Sources (APRINTDEMFONT)	0,196	0,206	0,907	0,219
Explanation of Variance	0,242	0,214	0,136	0,223

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais (2004), own elaboration.

Table A6 – Matrix of Factor Loading of Indicators on the Respective Factors and Explained Variance after Orthogonal Rotation of the Axes – Subgroup of Externa Learning and Cooperative Actions Indicators (N=298):

Indicators	Factor 1	Factor 2	Factor 3	Factor 4
Vertical Learning (APREXVER)	0,809	0,148	0,119	0,043
Horizontal Learning (APREXHOR)	0,761	-0,060	0,031	0,322
Learning through Institutions of Science and Technology (APREXC&T)	0,249	0,169	0,822	-0,059
Learning through Technical Services (APREXSERESP)	0,466	0,620	0,332	-0,202
Learning through Other Agents (APREXDEMAG)	0,791	0,256	0,168	0,077
Vertical Cooperation (COOPVER)	0,191	0,466	0,263	0,588
Horizontal Cooperation (COOPHOR)	0,165	0,206	0,072	0,835
Cooperation with Institutions of S&T (COOPINSTC&T)	0,026	0,019	0,848	0,281
Cooperation with Technical Services (COOPSERESP)	0,019	0,844	0,125	0,211
Cooperation with Other Agents (COOPDMAG)	0,158	0,759	-0,043	0,297
Explanation of Variance	0,223	0,205	0,164	0,141

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais (2004), own elaboration.

Table A7 – Matrix of Coefficients Used for the Extraction of Factor Scores – Subgroup of Innovative Performance Indicators (N=298):

Indicators	Factor 1	Factor 2
Radical Innovation in Products (INRDPRD)	-0,099	0,590
Radical Innovation in Processes (INRDPRC)	-0,096	0,592
Incremental Innovation in Products (INICPRD)	0,491	-0,146
Incremental Innovation in Processes (INICPRC)	0,452	-0,092
Organizational Innovations (INORG)	0,359	0,061

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais (2004), own elaboration.

Table A8 – Matrix of Coefficients Used for the Extraction of Factor Scores – Subgroup of Innovative Effort Indicators (N=298):

Indicators	Factor 1	Factor 2	Factor 3	Factor 4
Regularity in execution of R&D (CONSP&D)	0,003	0,636	-0,270	-0,079
Regularity in Acquisition of New Technologies (CONSNOVTEC)	0,644	0,007	-0,007	-0,336
Regularity in Pre-Innovative Effort (CONSESFPREINOV)	0,203	-0,027	-0,281	0,312
Regularity in Organizational Updating (CONSATORG)	0,555	-0,094	-0,019	-0,157
Training Effort (ESFTRERH)	-0,140	-0,171	0,177	0,513
Effort for HR Absorption (ESFABSRH)	-0,278	-0,089	-0,157	0,758
Internal Learning R&D Department (APRINTP&D)	-0,093	0,619	0,107	-0,207
Internal Learning Other Sources (APRINTDEMFONT)	-0,078	-0,107	1,036	-0,165

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais (2004), own elaboration.

Table A9 – Matrix of Coefficients Used for the Extraction of Factor Scores – Subgroup of External Learning and Cooperative Actions Indicators (N=298):

Indicators	Factor 1	Factor 2	Factor 3	Factor 4
Vertical Learning (APREXVER)	0,427	-0,058	-0,065	-0,086
Horizontal Learning (APREXHOR)	0,420	-0,252	-0,115	0,228
Learning through Institutions of Science and Technology (APREXC&T)	-0,009	-0,021	0,554	-0,177
Learning through Technical Services (APREXSERESP)	0,138	0,357	0,102	-0,407
Learning through Other Agents (APREXDEMAG)	0,387	0,004	-0,043	-0,085
Vertical Cooperation (COOPVER)	-0,064	0,104	0,061	0,371
Horizontal Cooperation (COOPHOR)	-0,030	-0,108	-0,058	0,675
Cooperation with Institutions of S&T (COOPINSTC&T)	-0,153	-0,179	0,607	0,187
Cooperation with Technical Services (COOPSERESP)	-0,168	0,507	-0,039	-0,037
Cooperation with Other Agents (COOPDMAG)	-0,053	0,427	-0,182	0,060

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais (2004), own elaboration.

Table A10 – *F* Distance and Significance of Factors in the Formation of Clusters (N=298):

Factors	3 Clusters		4 Clusters		5 Clusters	
	Dist. F	Signif. *P*	Dist. F	Signif. *P*	Dist. F	Signif. *P*
Factor of Incremental Innovations	129,647	0,000	140,039	0,000	111,617	0,000
Factor of "Radical" Innovations	120,263	0,000	84,731	0,000	134,220	0,000
Factor of Technological and Organizational Updating	41,702	0,000	30,576	0,000	23,561	0,000
Factor of R&D	45,645	0,000	97,010	0,000	57,620	0,000
Factor of Internal Learning	268,679	0,000	170,060	0,000	136,824	0,000
Factor of Training and Pre-Innovative Effort	39,218	0,000	49,268	0,000	41,762	0,000
Factor of Learning through Productive and Other Agents	183,476	0,000	134,575	0,000	87,081	0,000
Factor of Interaction with Technical Services	17,884	0,000	13,569	0,000	11,081	0,000
Factor of Interaction with Institutions of S&T	60,512	0,000	41,306	0,000	17,935	0,000
Factor of Cooperation with Productive Agents	6,713	0,001	8,745	0,000	46,451	0,000

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais (2004), own elaboration.

Table A11 – Distance between Clusters Using the Square of Mahalanobis Distance as Metrics (N = 28):

	Cluster 1	Cluster 2	Cluster 3
Cluster 1	0,00000	23,16030	35,12466
Cluster 2		0,00000	16,52710
Cluster 3			0,00000

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais (2004), own elaboration.

Table A12 – Participation of Enterprises of each Cluster in the Analyzed LIPSs and Participation of Enterprises of the LIPSs in each Cluster:

LIPS/ Cluster		Cluster 1 – "Enterprises of high dynamism"		Cluster 2 – "Enterprises of medium dynamism"		Cluster 3 – "Enterprises of low dynamism"		Total
		Nº	%	Nº	%	Nº	%	
Furniture in the Western Region of Santa Catarina	**Nº**	4	10,00%	63	39,62%	0	0%	67
	%	5,97%		94,03%		0%		100%
Wood in the region of Vale do Iguaçú-SC	**Nº**	3	7,50%	21	13,21%	31	31,31%	55
	%	5,45%		38,18%		56,36%		100%
Electrical and Metal-Mechanical in the micro-region of Joinville - SC	**Nº**	28	70,00%	44	27,67%	11	11,11%	83
	%	33,73%		53,01%		13,25%		100%
Plastic Materials in the Southern Region of Santa Catarina	**Nº**	4	10,00%	28	17,61%	4	4,04%	36
	%	11,11%		77,78%		11,11%		100%
Fishing in the region of Foz do Itajaí-SC	**Nº**	1	2,50%	3	1,89%	53	53,54%	57
	%	1,75%		5,26%		92,98%		100%
Total		40	100%	159	100%	99	100%	298

Source: Programa de Pesquisa Micro e Pequenas Empresas em Arranjos Produtivos Locais (2004), own elaboration.